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THE BIOLOGICAL LABORATORY OF THE BU-
REAU OF FISHERIES AT WOODS HOLE,
MASS.: REPORT OF WORK FOR
THE SEASON OF 1907

DR. FRANCIS B. SUMNER

DIRECTOR OF THE LABORATORY.

I. RECENT IMPROVEMENTS IN EQUIPMENT, ETC.

1. Two rooms upon the third floor of the laboratory building have been reconstructed so as to serve for the reception of the specimens comprising the local reference museum. These last were moved from their former inadequate quarters at the commencement of the summer, and have been subjected to a thorough overhauling.

2. A considerable number of standard scientific works were purchased by the bureau as the nucleus of a permanent reference library; though it is true that only a beginning has thus far been made. The already great collection of reprints and other miscellaneous donations, together with the reports of the scientific departments of this and other governments, has steadily increased. It was found, however, that the publications of many of our foremost American biologists were scarcely represented on the shelves of the library. With a view to remedying this serious lack, a circular was sent by the director to about three hundred American men of science, chiefly biologists, asking for contributions. A considerable number of these men responded liberally, and many hundreds of pamphlets and bound volumes have been received. It must be added with regret, however, that many others among those addressed have not yet thought it worth their while to place their writings in an institu

tion conducted solely for the public welfare, and offering free facilities each year to a large number of biologists.

3. A steam drying apparatus was purchased, at a total cost of over three hundred dollars, for use in experiments upon the methods of preparing various marine foods. Owing to serious delay on the part of the manufacturers, this apparatus was unfortunately not installed until late in the season.

4. Running fresh water was introduced into each of the large investigation rooms upon the second and third floors of the building, and enameled iron sinks were likewise installed in these rooms.

5. A contrivance was designed and constructed for the purpose of de-aerating the salt-water supply of the laboratory and aquarium.

6. The entire floor of the main laboratory room (162 square yards) was covered with a layer of heavy linoleum.

7. Electric table lamps, with parabolic reflectors, were substituted for the hanging lamps formerly used in the investigation rooms.

8. The supply rooms for apparatus and chemicals were greatly extended, and many improvements were effected by carpentry throughout the building.

II. BROADER LINES OF INVESTIGATION

1. *Biological Survey*.—Much progress was effected during the summer, as well as during the preceding winter, in the preparation of the report upon the biological survey of local waters. It has furthermore been necessary to extend this work through the present winter; and the director is again in residence at Woods Hole, engaged in the completion of this project. At the present time it may be stated that the plotting of the distribution charts, several hundred in number, has been nearly completed by Mr. J. W. Underwood; the compilation of an annotated list of the local fauna and flora (based both upon original observations and published records) is not

far from finished; the physical data (temperature, etc.) are being tabulated; and preparatory steps are being taken toward the statement of generalized results and conclusions. During the summer it was found necessary to repeat the temperature and salinity determinations of preceding years. The steamer *Fish Hawk* was employed for this purpose and recently standardized instruments only were used. In this work the director was ably assisted by Mr. D. W. Davis. Careful thermometry revealed temperature conditions which do much toward explaining the distribution of certain forms of life, especially of those well-known boreal types which just enter the region. This problem seemed of sufficient importance to justify another extensive series of temperature and density determinations at the commencement of the present winter, and these have therefore been made by the director, with the assistance of the crew of the *Phalarope*. A third series of observations is contemplated early in March; and possibly another at the commencement of the summer.

The *Fish Hawk* was also employed in doing considerable supplementary dredging; and the in-shore stations of Buzzards Bay, which, owing to an accident to the *Phalarope*, had been left unfinished in 1905, were now completed with the aid of the latter vessel. It is perhaps worthy of mention that the parasitic gastropod mollusk, *Stilifer stimpsoni* Verrill was taken for the first time (so far as recorded) in this region; and that the rare brittle star *Amphioplus abdita* (Verrill), which was recently made the subject of a special note in *Science*¹ by Dr. H. L. Clark, was dredged at no less than three stations.

With one or two exceptions, all past collections derived from the dredging operations have been reported on by the specialists to whom they were referred. More than half of the catalogue of fauna and flora has been submitted in manuscript form to these same taxonomic

¹ January 24, 1908.

experts for revision of nomenclature and other points. It is hoped that the entire report may be completed in the rough before the expiration of the coming summer.

As usual, a fish trap was maintained in Buzzards Bay, at a point not far distant; and the customary seining trips were made for the supply of laboratory needs, as well as to furnish data regarding the occurrence of species. As a fact of especial interest in relation to the local fauna may be mentioned the entire lack, during the past season, of the gulf-weed, and the accompanying stragglers from tropical waters, which frequently form such a striking feature of the marine life during the latter part of the summer.

2. *Studies of Marine Foods.*—Investigations have for several years been in progress, directed toward the utilization of certain marine organisms of apparently high food value, which have, notwithstanding, been hitherto neglected by our population. The “smooth” dogfish, the squid,² and the salt-water mussel have thus far received most attention at this laboratory. An arrangement was entered into with the “mess” of the Marine Biological Laboratory, whereby certain foods were prepared according to definite directions and served at certain of the dining tables. It was thus possible to obtain the opinions of a considerable number of persons as to the palatability of the articles in question. As already stated, a steam drying apparatus has been installed at this station as an important auxiliary to these experiments. Messrs. I. A. Field and C. L. Alsberg are engaged upon both the economic and the scientific aspects of this problem. Professor Field has already reported³ upon certain features in the bionomics of the dogfish and some other unutilized fishes, but much work remains to be done, on both the industrial and the chemical phases of the subject.

² It is here worth mentioning that two representatives of a Japanese produce establishment spent the summer on Cape Cod, taking steps toward the establishment of a plant for the drying of squid for exportation to their own country.

³ Bureau of Fisheries Document No. 622, issued 1907.

3. *Deaeration of the Laboratory Water Supply.*—The “gas disease” of fishes, especially as manifested in the aquaria at the Woods Hole station, has, in past years, been the subject of extensive investigations by Gorham and Marsh.⁴ These two writers presented convincing evidence that the cause of this malady lay in the super-saturation of the salt-water supply with air. The latter was shown to be forced into solution under pressure, during the process of pumping, so that the water which passes into the distributing tanks is “charged” with air, in much the same manner as soda-water and other carbonated beverages are charged with carbon dioxide. It is a familiar fact that such beverages quickly become “flat” if left to stand in an open vessel; and that the discharge of the gas is facilitated by agitating the liquid. Marsh found that in this principle lay a ready means of preventing the troubles arising from the super-saturation of the Woods Hole water supply. If the water, before its entrance into an aquarium or fish tank, were allowed to splash through a perforated pan, or merely to fall from a height as a fine jet, the evils of the gas disease would be diminished or altogether prevented. This method has since been generally adopted at the laboratory in connection with the large aquaria employed for display purposes, as well as with the smaller ones used for scientific experiments. It has commonly been necessary to employ the smallest stream of water practicable, allowing it to fall from a height, and commonly causing it to pass through a perforated pan, or to trickle over a board or other flat surface. Indeed, there have frequently been occasions when a strong stream, introduced beneath the surface of the water in a small aquarium, would prove fatal within a day or less, even to hardy fishes.

Such a state of affairs has obviously been a serious drawback to the work of the laboratory, which often

⁴ Bulletin U. S. Fish Commission, Vol. XIX (1899), pp. 33–37; Report U. S. Fish Commission for 1903 (1905), pp. 93–98; Report of the Bureau of Fisheries for 1904 (1905), pp. 343–376, pl. I–III.

demands that fishes shall be kept under observation, in a healthy condition, for days or weeks. Some method of treatment was deemed advisable which should be applicable to the water supply as a whole. Thus far, no attempts to prevent the entrance of air into the pump, along with the water, have been permanently successful. The wooden suction-pipe, through which the pump formerly received its supply of sea-water, was replaced, early in 1903, by a metal one, the assumption being made that the porous condition of the former was responsible for the trouble. Indeed, Marsh and Gorham, writing during the following year, declare that "the replacement of the old suction pipe with a new impervious one abolished all signs of the gas disease at Woods Hole." But the malady was again rife during the summer of 1905, and has given much trouble during the seasons of 1906 and 1907. In the absence of definite information as to the present source of the air in the water, the most promising mode of attacking the difficulty seemed to be the construction, on a large scale, of a *deaerator*, which should operate on the same principle as the pans and boards before employed for individual aquaria. Accordingly a series of five wooden trays was built, these lying in a zig-zag series, one above the other, and having a total bottom area of about 10,000 square inches, thus bringing a large surface of water into contact with the air. Perhaps the most effective factor in the case, however, is the splashing of the water in its descent from one trough to the other and from the lowermost of these into the supply tank below. From the latter the water is distributed to the laboratory.

This deaeration apparatus was not constructed until late in the past laboratory season, but the results of the tests already made seem well worth recording. The fatal effects of the water from the local supply had been conspicuous throughout the summer. It may be mentioned, by way of example, that in one wooden tank in the hatching room twenty tautog died in a single day, apparently

from this cause alone. In the display aquaria the fishes had fared pretty well, thanks to the use of perforated pans, which were suspended several feet above each tank. The water was in no case allowed to enter below the surface, as experience had shown that the result would have been disastrous. The deaeration apparatus was first put into use on August 31, and two days later the pans over these aquaria were removed, a full head of water being allowed to enter below the surface in each. This condition was maintained until September 23. During this period of twenty-one days no deaths occurred beyond those occasional ones to be expected in a large miscellaneous collection of living fish. No symptoms of the gas disease were noted, either in the presence of surface "blebs," or in the occurrence of "pop-eyed" fishes. The collection seemed in particularly good condition, and the absence of the splashing water overhead made it possible to keep the premises much more dry and neat.

The natural inference from these facts was that the deaerator had fulfilled its requirements perfectly. But before forming definite conclusions on this point, it was necessary to perform the control experiment of throwing the apparatus out of the circuit, and using the salt water just as delivered by the pump. This was done on the afternoon of September 23. The water supplying the aquaria was allowed to enter below the surface as before. On the following day (September 24) bubbles were noted upon the surface of some of the fishes, either in the mucus or beneath the epidermis. From records made throughout the ensuing twelve days, it appeared that out of 85 fishes, belonging to 18 species, which were present at the time the process of deaeration was discontinued, 13, or more than 15 per cent., died within the ensuing six days; while within the first twelve days 15 others, or nearly 18 per cent., manifested more or less marked symptoms of the gas disease. Almost exactly one third of the stock had accordingly been killed or obviously injured.

III. SEVENTH INTERNATIONAL ZOOLOGICAL CONGRESS

One of the prominent features of the program for the entertainment of the congress was a visit to Woods Hole on Sunday, August 25, when the members were welcomed jointly by the Marine Biological Laboratory and the Fisheries Laboratory. After a lunch served in the "mess" hall of the former institution, the party was carried to New Bedford on the U. S. Fisheries steamer *Fish Hawk*. One drag with the dredge was made *en route* by way of demonstration. On the preceding evening an informal smoker was tendered by the research staff of the Fisheries Laboratory to the local scientific colony and to such of the foreign delegates as had already come to Woods Hole in response to a special invitation. Thirteen of these visitors⁵ were housed for the night in the residence building of the station. A few of the most eminent of the foreign delegates, including Hubrecht, Bateson, von Graff and some others, had spent a week or more at Woods Hole prior to the visit of the congress; not, however, as the guests of this laboratory.

IV. INDIVIDUAL RESEARCHES

Of the twenty-five or more persons employed in various capacities on behalf of the laboratory, thirteen may, from the nature of their work, be ranked as investigators, the others serving as assistants, janitors, etc. Fourteen volunteer (unpaid) investigators likewise held tables and carried on independent lines of research. These twenty-seven investigators represented 11 states and 21 educational institutions,⁶ ranging from New Hampshire to Michigan and Virginia. A detailed statement of individual researches is given below.

The hospitality of the station was likewise extended to a number of gentlemen who are not strictly to be enrolled

⁵ Messrs. Derjugin, Golovine, Heymons, Koshewnikov, Kusnezov, Le Souëf, Maximow, Metalnikoff, Nedrigoiloff, Samssonow, Wladimiroff and two others (record lost).

⁶ Each being accredited to the institution in which he had taught or studied during the preceding academic year.

among those conducting investigations in the laboratory during the past season. Among these are to be named the Hon. K. Gupta, of Bengal, who was making a study of American fisheries methods on behalf of his government; Messrs. G. Asaya and T. Miyake, who were seeking information in regard to the local occurrence of the squid; and Professors W. A. Locy, Henry F. Nachtrieb and S. P. Sigerfoos, who visited Woods Hole briefly at about the time of the zoological congress.

Carl L. Alsberg, M.D., instructor in biological chemistry, Harvard Medical School.—The greater part of Dr. Alsberg's work consisted in the collection and preparation for analysis of various marine animals which are either not used, or little used, as foods in this country. The complete analysis of such material was deferred until the winter months, when better facilities for analytical work would be available than it is possible to provide at Woods Hole. The work actually done at Woods Hole was to determine the water content of the different materials, as well as the proportion of soluble proteid, etc. The other analyses are now being carried out in Boston. As a result of this work, it has become evident that in order to obtain reliable information concerning the food value of many of these forms it is necessary to study the extractives. As is well known, the extractives of ordinary meats have but little food value. For some of the lower forms, notably the dog fish, this is true to an even greater degree, because this fish contains large quantities of urea dissolved in the blood plasma and in the body fluids. In order to arrive at a correct estimate of the food value of such an animal, it is necessary to determine by accurate methods the urea content, and perhaps also that of the other extractives. Concerning the extractives of other forms at present under investigation, for instance the squid, nothing at all is known, and it will be necessary to make a study of them before we can estimate the food value of this mollusk. In addition to this line of work,

which has immediate practical value, various other investigations were undertaken, or at least the material for such investigations was collected. The study of the blood of the horse-shoe crab was begun, and two researches have been subsequently completed in Boston, both of which were presented at Chicago during the present winter, one before the American Society of Biological Chemists, and the other before the American Physiological Society. The first deals with the study of the blood-clot of this animal; the second started with a study of the enzymes of the serum and has led indirectly to interesting results concerning the guajac reaction of per-oxydases. Another investigation, the material for which was collected at Woods Hole, has also been finished subsequently. This is a study of the vitelline contained in the eggs of the spiny dog-fish. This vitelline has proved to be very similar to that which may be obtained from hens' eggs. Finally, an examination was undertaken, but not yet completed, into the nature of the red pigment contained in the chromatophores of the skin of the squid.

Charles B. Bennett, graduate student, Brown University, (1) took part in the work of the biological survey, being engaged in a search for certain marine organisms concerning which additional data were required, (2) assisted Dr. Alsberg and Professor Field in some of the work above described.

Walter B. Cannon, A.M., M.D., professor of physiology, Harvard Medical School.—*The Movements of the Aliimentary Canal in the Dog-fish*. Peristaltic waves were seen to pass over the lower third of the cardiac end of the stomach, but they did not pass on to the pyloric end. Along the narrow pyloric portion the waves were more frequent than on the cardiac portion. Three movements were seen in the spiral valve: (1) A segmenting movement, starting anteriorly as a constriction, which was replaced by a constriction one centimeter below, and this

by another one centimeter below that, etc., until the whole intestine was traversed. When the series had passed three or four centimeters from the starting point, a new series began. (2) A movement starting posteriorly and passing forward, which consisted in a local shifting of the wall towards the left, *i. e.*, clock-wise with reference to the axis of the valve viewed from behind. As shown by small holes cut in the wall, the shifting of the wall towards the left was accompanied by a shifting of the inner folds towards the right. The effect must be a thorough mixing of the food between the two surfaces. (3) A large general shifting of the valve forwards, and with a right rotation through about 180°. This was caused by a great sheet of smooth muscle lying in the mesentery between the genital gland and the spiral valve.

Joseph F. Clevenger, M.A., acting professor of chemistry and biology, Wheaton College, Wheaton, Ill.—*The Life History of Zostera marina and Ruppia maritima.*

Harold S. Colton, M.A., graduate student, University of Pennsylvania.—*How "Fulgur" and "Sycotypus" eat Oysters, Mussels and Clams.* The work, so far as performed at Woods Hole, consisted of a series of experiments and observations on the food of *Fulgur* and *Sycotypus* (*Busycon carica* and *B. canaliculata*), supplementing some which were begun at the University of Pennsylvania during the preceding winter. There had previously been no complete account of the taking of food by those gastropods. Stimpson (1860) and Ingersoll (1884) have mentioned their food; the former not completely and the latter not correctly. The present studies dealt with the kind and amount of the food and their manner of taking it. (1) Although pieces of chopped oyster were found to stimulate these mollusks, the latter were never observed to eat them. *B. canaliculata* ate living *Mya*, *Ostrea* and *Mytilus*, but refused *Venus*. *B. carica* accepted *Mya*, *Ostrea*, *Mytilus*, *Modiolus*, *Ensis* and *Venus*,

and devoured one of each. (2) It was frequently found that one individual ate two oysters or clams in a day; there usually being a long period of rest between meals, the animal remaining buried nearly all the time, sometimes for as much as six weeks. (3) The character of the erosion, noticed on the odontophore, indicates that these mollusks are not shell borers. (4) When clams (*Mya*) are the objects of assault, no difficulty is encountered in gnawing out the soft parts, since the shells of the latter gape slightly. The mussel and oyster, on the other hand, are taken by surprise. The attacking gastropod thrusts the margin of its own shell between the valves of that of the prey, devouring the soft parts at leisure. In the case of the "round clam" (*Venus*), *B. carica* uses yet another method of attack. Holding the bivalve in the hollow of its foot it brings the margin of its own shell against the margins of that of its prey. By the contraction of the columellar muscle, the two are brought into such forcible contact that a small piece is chipped from the *Venus* shell. This is repeated many times, the process lasting from seven hours to three days, with the result that the crevice between the two valves is enlarged to such an extent that the gastropod can devour its victim. (5) It is possible that the two species of *Busycon* do not inflict so great damage upon oyster or clam beds as has previously been reported. Field observations alone can settle this point, however.

Edgar D. Congdon, M.A., Austin teaching fellow, department of zoology, Harvard University, conducted investigations upon the fauna of the brackish waters in the neighborhood of Woods Hole. A number of these ponds were studied intensively, collections being made of their fauna and flora, and determinations of density and temperature being taken. A series of other ponds was likewise visited for purposes of comparison. Mr. Congdon also acted as librarian of the laboratory, and considerable time was devoted by him to classifying and cataloguing

the now rather unwieldy collection of miscellaneous reprints.

Bradley M. Davis, Ph.D., past assistant professor of botany in Chicago University, finished during the summer the catalogue of the marine algæ, together with a section of the report dealing with the distribution of algæ and *Zostera* in the deeper waters of the bay and sound. Much of this manuscript had been written during the preceding spring, Dr. Davis having spent the months of April and May at the laboratory. The catalogue will contain more than 250 species of algæ, with records of their distribution and seasonal habits; and will include a list of the stations at which they were dredged. An introductory section on the general characteristics of the algal life of Buzzards Bay and Vineyard Sound has since been written, and the manuscript covering the botanical side of the survey is now practically complete, except for such editing as may be necessary to make the botanical and zoological portions conform in arrangement and style. An important part of the summer's work in botany was the completion of maps showing the distribution of 75 species of algæ which grow in the deeper waters of the bay and sound. It is expected that the most important of these maps will be published in connection with the catalogue, since they show, much more clearly than is possible in a mere description, the striking features in the distribution of the most characteristic species.

Donald W. Davis, professor of biology, Sweet Briar College, Sweet Briar, Va.—(1) *An Investigation of the Effects of Various Conditions acting at the Time of Impregnation upon the Size and Vigor of Fish Embryos*. For the time being, attention was restricted to the effects of various *temperatures*, and *Fundulus heteroclitus* was selected for experimentation because of its convenient spawning period. Each lot of eggs, taken from a single

female, was divided into equal parts. These parts were then fertilized by milt from a single male at temperatures differing from each other by 5° , 10° , 15° or 20° C. After a few minutes the two parts were again brought under identical conditions and so kept until hatching. At the expiration of a certain period, when practically all of the living embryos had hatched, all were fixed by the aceto-sublimate-formalin method, which was found to leave them well straightened. Careful records of mortality, rate of hatching, etc., in the different lots were kept. Measurements to be made upon the embryos, with a view to determining the tangible effects of such differences in treatment, are not yet complete. (2) A study of the alleged interference in branchial circulation resulting from the transfer of fishes from salt to fresh water, and *vice versa*, was also taken up. The conclusion of Bert and Mosso that such interference occurs in consequence of a clogging of the branchial capillaries by distorted blood corpuscles, was thought to be worth testing in view of recently published work by the director of the laboratory upon some other effects of changes in salinity. The common smooth dog-fish (*Mustelus canis*), the scup (*Stenotomus chrysops*) and the killifish (*Fundulus heteroclitus*) were experimented upon, the first two named being species which succumb quickly when transferred to fresh water, while the last named is commonly able to survive for some days in fresh water. The hypothetical clogging of the branchial vessels in these species was tested by passing physiological salt solution through the conus arteriosus at definite pressures, and the gills were then fixed for microscopical examination. Results immediately apparent revealed no such contrast as the statements of both Bert and Mosso would lead one to expect between fishes taken directly from salt water and those dying in fresh water. Further work will be necessary before a more definite statement of the results can be made.

Irving A. Field, professor of chemistry and biology, Western Maryland College, conducted experiments, to which allusion has already been made, with a view to testing the food value of certain hitherto unused marine animals. These were tested in respect to their palatability and digestibility by serving them, properly cooked, to numerous persons, who passed judgment on the quality of the food and the effects subsequently observed. Determinations of the chemical composition and nutritive value of the materials in question were, as has already been stated, undertaken by Dr. Alsberg. Various methods used commercially for the preservation of fisheries products (drying, salting, pickling, etc.) were applied to the forms studied. Statistics relating to the abundance of each species and the cost of preparing it for the market were also kept.

John H. Gerould, Ph.D., assistant professor of zoology, Dartmouth College, devoted a few days to the collection and study of a rare and hitherto undescribed species of sipunculid. Although two dredging trips were made with the *Fish Hawk* and the *Phalarope* for this express purpose, but a single specimen was obtained, which, however, was observed in a living condition, an opportunity which was regarded as of considerable value.

Charles W. Hargitt, Ph.D., professor of zoology, Syracuse University.—(1) *A Monographic Synopsis of the Anthozoa of the Region*. But little systematic attention has been devoted to the local representatives of this group since the work of Verrill and Smith more than thirty years ago. It has been the purpose of Dr. Hargitt to secure as full collections as the facilities at hand rendered possible, and to carefully review the group with reference to the species, their distribution, habits, development, etc. This work is now nearing completion so far as its laboratory phase is concerned, and will soon be ready for publication. At least one new species has been

found, and one or more have not as yet been identified with certainty. Some additional facts as to distribution and habits are likewise to be reported. (2) *Systematic Determinations of Local Cœlenterate Animals, as related to the Biological Survey now in Progress.* The survey has brought to light a number of new species of hydroids and medusæ, and a few hitherto quite unrepresented in the fauna of the region. Some account of these may be found in some recent "Notes on the Cœlenterate Fauna of Woods Hole."⁷ Others remain to be determined. Dr. Hargitt accompanied many of the dredging expeditions made, and thus personally collected most of his specimens in the living state, as they came up in the dredge. Opportunity was thus afforded for obtaining data as to color, etc., which are of much importance in such determinations. (3) The manuscript of the catalogue of local fauna and flora, so far as this relates to the Cœlenterata, was criticized and revised as to nomenclature. (4) Some living specimens of the fresh-water medusa, *Limnocodium*, were received from the Bureau of Fisheries. A brief notice of these has already appeared in *Science* (November 8, 1907). A fuller account of this most interesting medusa is ready, and will appear in the near future.

George T. Hargitt, teacher of zoology, Syracuse (N. Y.) High School (now graduate student in Harvard).—*Studies of the Embryology of the Hydromedusæ.* The work on the embryology of the cœlenterates has been most often limited to two phases, viz., the place of origin of the germ cells and development of the medusa or gonophore; and the late cleavage of the egg, with the formation of the germ layers and the development of the planula and polyp. While attention has been so largely confined to the early cleavage and maturation of the egg, the results have been rather unsatisfactory and inconclusive, and often conflicting. The work under way is an

⁷ *Biological Bulletin*, January, 1908.

attempt to supply the missing or less known phases of the early development of the cœlenterate egg, and especially that of the Hydromedusæ.

John D. Haseman, M.A., graduate student, University of Indiana.—*Studies of the Reactions of the Gastropod Litorina litorea to Stimuli*. Experiments were conducted, both in the laboratory and in the field, with a view to determining the conditions and stimuli which were responsible for the movements of these mollusks and the positions chosen by them. It is believed by the writer that Mr. Haseman has already prepared for publication a paper embodying the results of these studies.

William B. Herms, A.M., Ohio Wesleyan University (now fellow in zoology, Harvard University).—*A Comparative Study of Palæmonetes*. The habits, post-embryonic development and other facts in the natural history of the common local prawn, *Palæmonetes vulgaris*, were studied in relation to similar observations already made upon the related *Palæmonetes exilipes* of Lake Erie. Interesting points, both of similarity and of difference, were brought to light. A very close relationship between the two species undoubtedly exists. Several attempts were also made to acclimatize larvæ to higher and lower degrees of salinity.

William E. Kellicott, Ph.D., professor of biology, Woman's College, Baltimore.—*Biometric Studies of the Dog-fish (Mustelus canis)*. The season was spent in the collection of data bearing on the general problems of correlation, growth, etc., in the dog-fish. A quite complete series of measurements, including about 30 characters, internal as well as external, was made upon about 300 individuals. Dr. Kellicott is at present working over these data and examining into the rate of increase in weight of the brain and viscera. Some interesting facts have revealed themselves, and it is believed that a paper embodying these will be ready in the near future.

Charles R. Knight, American Museum of Natural History, New York City, was engaged, as has been the case for several summers, in portraying pictorially some features of the local sea life. Mention may be made in particular of a tiger-shark (*Galeocерdo tigrinus*), and a dusky shark (*Carcharimus obscurus*). Of the latter, a specimen over ten feet in length was taken in the laboratory's fish trap, and was kept alive for a few days in the shark-pool belonging to the station. The lobster, blue crab and scup also received attention, a large canvas being devoted to a group of the last.

Edwin Linton, Ph.D., professor of biology, Washington and Jefferson College.—(1) Besides examining such fishes as were available among those taken in the fish trap of the Bureau in Buzzards Bay, a preliminary study was made of a large amount of material from fishes and fish-eating birds, collected during the preceding nine months by Mr. Vinal N. Edwards. In agreement with the experience of previous years was the fact that new habitats were found for species already known, and new or unrecorded species were added to the list of those previously known. Thus new species or new habitats were recorded for 21 species of fish. Adult specimens of *Tetrarhynchus bicolor* were encountered for the first time. They were found in the stomach of a dusky shark. Scoleces of this species had, however, been found in this and other hosts during previous years. The pigment which gives the characteristic color to the head and neck of this cestode was not dissolved by the killing fluid (chrom-acetic-formalin), and has not been decolorized by the alcohol in which the worms are preserved. (2) Of the pathological and diseased conditions which were noted, an interesting one is the case of an abnormal growth of the swim-bladder of a scup. This, when first seen, was a slender, white, vermiform object about two millimeters in diameter lying among the muscles of the side. It was at first thought to be a cestode, examples of which occa-

sionally penetrate the muscular tissue of their hosts. Upon tracing it forward, it proved to be a lateral prolongation of the anterior end of the swim bladder. At its origin it corresponded in structure to the swim bladder, but at its posterior (*i. e.*, distal) end it was rather firm and the walls were thickened. The alcoholic specimen, which has contracted somewhat, is 60 millimeters in length. (3) Butterfish were examined on five occasions for the flesh parasite described in the Bulletin of the Bureau of Fisheries.⁸ The proportions of infected fishes were rather less than in previous years. (4) Considerable attention was given to the parasites of the puffer (*Spherooides maculatus*) with a view to preparing a special paper on the entozoa of that fish. (5) The preparation was begun of tables of the distribution of the parasites of fishes based upon collections made by Dr. Linton, at Beaufort, Bermuda, Tortugas and Woods Hole. These tables have since been completed and sent to the Bureau of Fisheries at Washington. (6) A beginning has also been made in the collecting of parasites from invertebrate hosts for the purpose of securing stages in the life history of those parasites of fishes whose early stages are found in invertebrates.

Albert J. May, A.M., instructor in the Boys' High School, Reading, Pa., made observations upon the medusæ of various local hydroids, and collected material for future study. *Corymorpha pendula*, which was especially sought for, on account of obscure facts in its life history, unfortunately proved to be very rare.

Hansford MacCurdy, Ph.D., professor of biology, Alma College, devoted most of his time to the study and tabulation of results obtained during the preceding summer relating to the hybridization of echinoderms.

William J. Moenkhaus, Ph.D., associate professor of physiology, University of Indiana, continued studies,

⁸ Vol. 26, pp. 111-132.

begun some years ago, upon the hybridization of fishes belonging to widely separated genera and families. Such cross-fertilized eggs did not commonly hatch, or even develop far, but an interesting range of abnormalities was produced. A few experiments in cross-fertilizing certain invertebrates were likewise undertaken.

Raymond C. Osburn, Ph.D., instructor in zoology, Barnard College, Columbia University, was occupied chiefly in the preparation of a report upon the local marine bryozoa, basing this work for the most part upon collections made in the course of the biological survey during the past five summers. On account of the great abundance and almost universal distribution of many of these animals locally, the need of such a monograph has been much felt. Dr. Osburn has already found a considerable number of species which are new to the region, as well as discovering errors in the previous identification of certain common local forms.

Jacob Reighard, Ph.D., professor of zoology, University of Michigan, experimented upon certain features of the behavior of *Fundulus heteroclitus*; likewise compiled results obtained earlier in the summer at the Carnegie station at Tortugas, where experiments had been performed with the object of testing the alleged warning coloration of various brilliantly tinted tropical fishes.

Russell Richardson, graduate student in the University of Pennsylvania (now assistant in the department of comparative physiology, Harvard University).—*Response of Limulus Muscle to the Electric Current*. The two large lateral tail muscles were generally used. Both constant and interrupted (induced) currents were employed; and the stimulus was applied either by wires or by non-polarizable electrodes. Endeavor was made to find out whether there was more than one form of curve to be derived from induced shocks, as had been found by some

workers; but all such attempts gave negative results, only one form of curve being obtained. The contraction is very rapid, and the height of the curve varies, within certain limits, as the strength of the stimulus. The relaxation is rapid at first, but later takes place more slowly. Summation is more or less regular. With constant current there were generally obtained the usual stimulations at the make and break of the circuit. The form of the curves varied greatly, however, according to the direction in which the current traversed the muscle. The weak constant current caused a marked relaxation of the muscle, only when passing through it in an ascending direction. Fatigue in *Limulus* seems more or less regular. As it progresses, there is a noticeably greater interval between the contraction and the relaxation. The latter also becomes much slower. After this stage, the height of contraction gradually diminishes until no response at all is obtained.

George G. Scott, A.M., instructor in biology, College of the City of New York.—(1) *The Effect of Poisons, at Different Temperatures, on Fundulus heteroclitus*. Sixteen experiments are recorded. In each case two lots of fish were used, one lot being kept at the temperature of the laboratory, *i. e.*, about 70° F., while the other lot was kept at a lower temperature, *i. e.*, about 50° F. Different dilute solutions of a variety of organic and inorganic poisons were used. In eleven of these experiments it was distinctly shown that the effect of the poison was greater at the higher temperature; in four, the result showed no difference; while in one, the result was opposite to the first named effect. (2) *The Effect of Change in Density of the Water on the Blood of Fundulus heteroclitus*. It has been recently shown by Sumner that there may occur a passage of fluids into or out of the bodies of teleost fishes when the density of the medium to which they are accustomed has been sufficiently changed. This has been proved by demonstrating the occurrence of changes of

weight, and by other means. It seemed worth while to ascertain what effects, if any, such changes of water density have upon the blood. The results of a few typical experiments are here stated. Hæmacytometer determinations were made upon fishes subjected to different conditions. The mean blood count of a number of specimens of *Fundulus heteroclitus* in natural sea water was found to be 2,700,000 red corpuscles per cubic millimeter. Sea water contains about 3.5 per cent., by weight, of salts in solution. In an experiment in which the salt content of the water was increased to over 6 per cent. by the addition of sea-salt, the proportion of corpuscles had increased to about 3,500,000 per cubic millimeter. In the case of another lot of fishes which were placed in 1,500 cc. of sea water, to which 30 grams of sea-salt had been added, it was found after six hours that the number of corpuscles was 2,800,000 per cubic millimeter. In yet another lot which were placed in 1,500 c.c. of sea-water plus 60 grams of sea-salt, the blood count, at the end of six hours, gave 3,000,000 corpuscles. In a case in which 120 grams of sea-salt were added to 1,500 c.c. of sea-water the blood count gave 3,900,000 per cubic millimeter. A number of fishes were placed in sea water artificially strengthened to the point of containing about 9.5 per cent. of salts. After one hour it was found that the fishes had lost in weight, while the blood counts of two specimens averaged 2,800,000; at the end of two hours, a further loss in weight was noted in the remaining fishes, and in two specimens the average number of corpuscles counted was now 3,434,000 per cubic millimeter. Fishes which were placed in distilled water and subjected to the hæmacytometer test an hour and a half later yielded about 2,000,000 corpuscles to the cubic millimeter. In two experiments with distilled water there was at first a *decrease* in the number of corpuscles counted, then a gradual *increase* up to the normal, which increase later passed above the normal. The question as to whether or not the blood is diluted by the osmotic influx of water

can likewise be investigated by determining whether the freezing point of blood serum from a fish which has been kept in fresh water is higher than that of blood serum from a fish taken from its normal medium. Although experiments of this sort had already been performed by a number of competent investigators, it seemed worth while to make the test again. This was impossible to do in the case of *Fundulus* on account of the small amount of serum obtainable. The experiment was carried out, however, upon *Mustelus canis*, the "smooth dog-fish."⁹ Five determinations were made with the blood serum of fishes taken from normal sea water, and five with blood serum of fishes that had been kept in fresh water for an hour. These experiments agreed in showing that the freezing point of serum from fishes kept in fresh water is much higher than that of fishes taken from sea water. It was thus demonstrated that the blood of fishes may be diluted by a sojourn in fresh water, and support is given to the view that the change in the number of corpuscles counted was due to dilution or concentration of the blood. The last mentioned experiment upon *Fundulus*, in which distilled water was used, suggests that after the first dilution of the blood, due to the physical process of osmosis, there occurred a physiological reaction on the part of the organism, the excess of water being expelled from the blood. That it remains in the body of the animal, however, is shown by the persistent increase in weight.

Francis B. Sumner, Ph.D., director U. S. Fisheries Laboratory, Woods Hole, Mass.—(1) The supervision of the *biological survey*; (2) experiments in the deaeration of the local salt-water supply; (3) an investigation into the meaning of the color variations of *Litorina palliata* Say (carried on jointly with James W. Underwood). The first two of these lines of investigation have already been discussed in the more general part of the paper; a

⁹ The known physiological differences between elasmobranchs and teleosts can not, of course, be left out of consideration.

synopsis of the third has appeared in a recent issue of *Science*¹⁰ and need not be repeated.

James W. Underwood, student and assistant in Olivet College, (1) assisted in the work of the biological survey, being occupied for some months in plotting out the distributions of the more frequent local species upon maps which had been printed for the purpose; (2) collected and studied the species comprising the local plankton during the spring season; (3) cooperated with the director in the above mentioned study of the color variations of *Litorina palliata*.

Ralph E. Wager, A.M., teacher of biology, state normal school, Potsdam, N. Y.—*Studies of the degenerative Changes in Hydroid Polyps under the Influence of Changed Polarity or Contact Stimuli*. Experiments were performed for the purpose of providing material in different stages of degeneration, with the object of subsequently studying not only the histology, but more particularly the cytology of the changes. Abundant material was at hand in the various species of *Obelia*, and a sufficient supply of the degenerating polyps was obtained to thoroughly test the killing and fixing methods, if not to satisfy the demands of the problem. Thereafter experiments were performed on *Gonionemus* for the purpose of obtaining regenerating tissues, with a similar intention of determining the cytological changes involved in their growth. Again a plentiful supply of material was available, and enough of the regenerating tissues was obtained to make possible a fairly thorough study.

¹⁰ March 27, 1908.